

CELANESE CHEMICAL COMPANY, INC.
TECHNICAL CENTER
Corpus Christi, Texas

DDD-38-81
WNU-17-81

Redox II Design and Economics Update

Dallas

*C. S. Aichler
*O. Axtell
J. J. Cahill
**S. A. Douglass
*E. H. Drew
**T. D. Hinson
M. C. Meador
H. D. Medley
*H. L. Pilat
W. J. Wells
**E. N. Wheeler

CCCTC

A. Aguilo
**J. S. Alder
G. A. Blay
**C. J. Brugger
S. Bustabad
**F. C. Chanslor
*J. D. Chase
J. Chosnek
J. R. Christenson
P. M. Colling
T. A. Curtis
E. M. De La Garza
**D. D. Dickinson
R. D. Farr
G. J. Fisher
H. R. Gerberich
**W. E. Heinz
C. C. Hobbs
**C. B. Hilton
T. M. Kenesson
J. D. Penrod
*R. M. Pritchett
M. Singh
**W. E. Taylor
**W. N. Uber
*P. J. Volpe
R. J. Voorhoeve

New York

L. I. Grim
*M. Turken

Redox Technologies, Inc.
**J. Kollar

Summit

A. B. Baylis
H. C. Linstid
R. D. Mikkilineni
*D. R. Wilson
**J. A. Broussard

Uniterms

Redox Technologies, Inc.
Design
Economics
Update
Ethylene Glycol
Process
Comparison
Redox II
Syn Gas
Shell
Purification
Acetone
Glycerine
Propylene Glycol

* Summary only
** With appendices

S/N 642

CELANESE CHEMICAL COMPANY, INC.
TECHNICAL CENTER
Corpus Christi, Texas

To: W. E. Heinz

From: D. D. Dickinson
W. N. Uber

DDD-38-81
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Redox II Design and Economics Update

SUMMARY

A detailed design and economic update for the Redox II ethylene glycol (EG) process shows a moderate (5%) NSR advantage over Shell. A more attractive R&D target case (higher EG wt%) has a 14% advantage over Shell. These results are summarized below for 500 MM lb/yr EG units (1989 construction, 1990 operation):

	REDOX II			CZ
	Base Case	R & D Target	Shell	Syn Gas
Raw material cost, contained EG (a)	39.1	39.1	62.8	22.4
TFC, \$MM	319	278	265	525
TFC contribution, c/lb EG	19.8	17.3	16.1	48.0
Raw materials, c/lb	69.8	73.0	64.3	31.4
By-products, c/lb				
Glycerine	(4.3)	(4.3)		(20.9)
Acetone	(14.8)	(19.3)		
t-Butanol	(6.3)	(2.1)		
Ethanol	(3.0)	(10.1)		
Others	(4.8)	(3.3)	(9.0)	(8.3)
Totals	(33.2)	(39.1)	(9.0)	(29.2)
Utilities, c/lb	21.2	17.2	8.5	13.8
Cat & Chem, c/lb	0.1	0.1	1.8	3.8
ENSR , c/lb EG	79.5	71.3	83.3	71.1
Shutdown NSR			63.8 (b)	

(a) No byproducts; Shell @ 70% effy, others @ 100% effy

(b) Shell shutdown NSR as zero cash flow

APPENDIX B
BLOCK 2 - TBHP ALKYLATION

- Table B-I: Capital/Utilities Summary
- Figure B-1: Process Flow Diagram
- Table B-II: Block Capital Estimate
- Table B-III: Block Material Balance

Process Description

T-butyl-hydroperoxide (TBHP) is alkylated with isobutylene to DTBP in the liquid phase in the presence of strong acid ion exchange resin. Low temperature (70°C) helps ensure resin stability, while maintaining rates (30 min. res. time). Excess isobutylene (23%) ensures complete TBHP conversion in the plug flow reactor.

Excess isobutylene is removed in a single distillation step. Low base temperature of 115°C prevents DTBP decomposition. Product DTBP is immediately cooled and stored for feed to the Redox reactor.

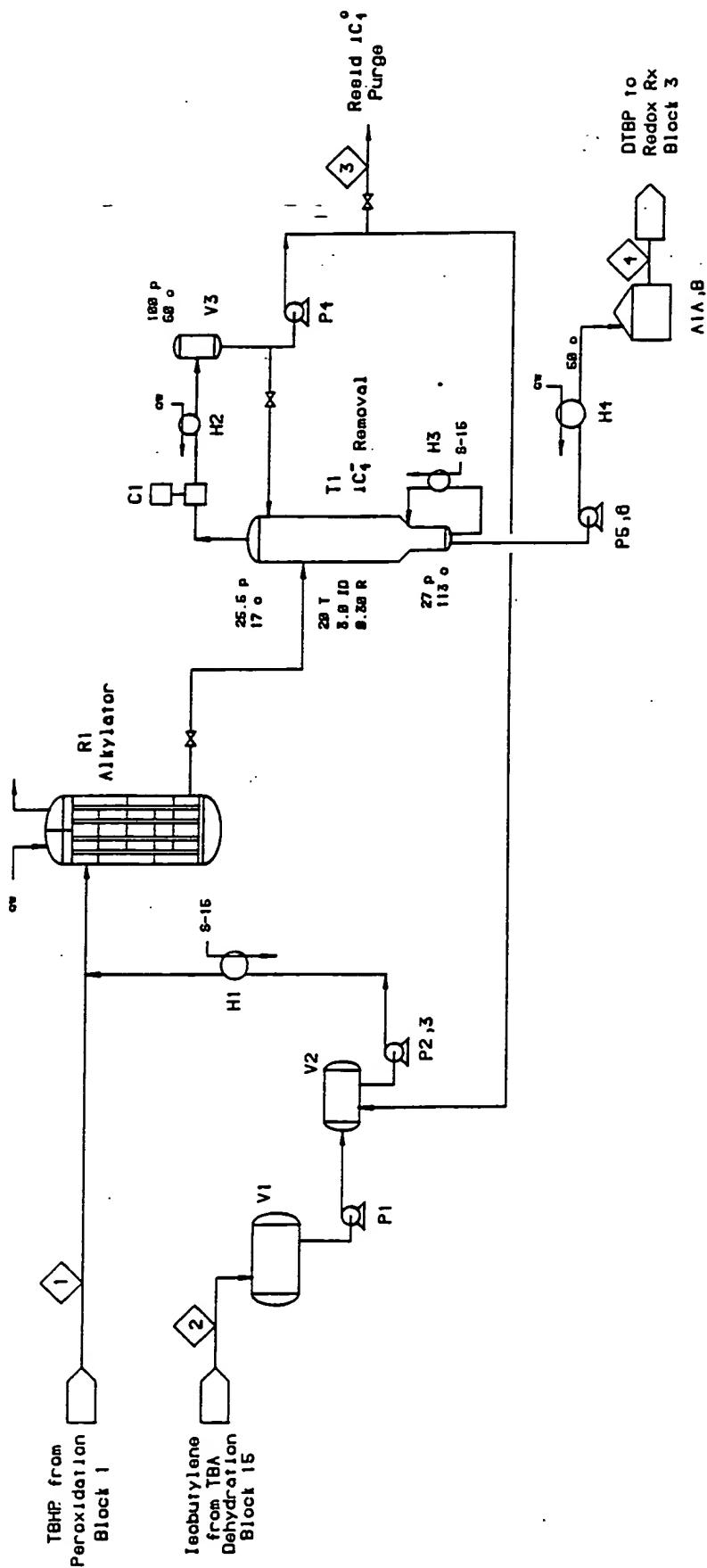
TABLE B-I
CAPITAL/UTILITIES SUMMARY

Block 2--TBHP Alkylation

TFC (1877 MSI): \$ 9.6 MM

	Units/lb EG
Electricity, KWH	0.0015
Steam, lb: S-15	0.06
Cooling Water, gal	0.8

FIGURE B-1
BLOCK 2 -- TBHP ALKYLATION
Detailed Process Flow Diagram



--DO NOT REPRODUCE--
FOR USE WITHIN CELANESE CORP. ONLY

TABLE B-II

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REDOX II // ALKYLATION--BLOCK 2
ODD/MAY 13 1981*****
* SUMMARY OF RESULTS *

CASE STUDY FOR PLANT CAPACITY TIMES 1.49

YEAR= 1981
 MSI= 1877
 BASE MSI= 670

EQUIPMENT TYPE	DELIVERED EQUIPMENT COST MS	RL/DEC RATIO	BATTERY LIMITS COST MS
VESSELS	288.68	5.09	1469.15
ATM TANKS	333.72	2.55	850.56
TOWERS	83.36	5.89	490.79
XCHANGERS	1485.47	1.91	2830.08
PUMPS	47.16	10.75	507.10
COMPRESSORS	102.77	3.46	356.07
BLOWERS/FANS	0.00	0.00	0.00
FURNACES/HOILERS	0.00	0.00	0.00
REFRIGERATION	0.00	0.00	0.00
MISCELLANEOUS	0.00	0.00	0.00
<hr/>			
*** TOTALS	2341.16	2.78	6503.75

BATTERY LIMITS PLUS 20.0 PERCENT CONTINGENCY IS:
 (CONTINGENCY IS OVERALL PROCESS AND ESTIMATING)

7804.49

REDOX 111 // ALKYLATION--BLOCK 2
DD/MAY 13 1981

TOTAL PLANT (BATTERY LIMITS)

CASE STUDY FOR PLANT CAPACITY TIMES 1.049

	DELIVERED EQUIPMENT (\$M\$)	DIRECT LABOR (\$M\$)	INSULATION AND PAINT (\$M\$)	PIPING (\$M\$)	INSTRMNTS (\$M\$)	ELECTRCL (\$M\$)	CIVIL (\$M\$)	ENG/CUNS OVHD (\$M\$)	TOTAL (\$BL) (\$M\$)	BL/DFC RATIO
VESSELS										
ATM TANKS	333.72	6.74	22.69	57.43	110.10	179.20	48.66	179.22	530.95	1469.15
TOWERS	83.36	1.77	11.85	157.46	61.41	3.02	26.45	145.47	490.79	5.89
HEAT EXCHANGERS	1485.47	27.87	36.69	158.72	93.53	61.88	337.30	628.62	2810.08	1.91
PUMPS	47.16	2.18	5.09	90.23	7.00	58.21	54.06	243.17	507.10	10.75
COMPRESSORS	192.77	2.52	5.61	16.19	26.92	44.09	37.01	120.96	356.07	3.46
FLOWERS/FANS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FURNACES/BOILERS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REFRIGERATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MISCELLANEOUS	0.00	0.00	0.00	6.97	0.00	0.00	0.00	0.00	6.97	0.00
*** TOTAL	2341.16	47.86	207.47	597.11	395.94	265.59	738.14	1917.44	6510.71	
PERCENT DFC	100.00	2.04	8.86	25.50	16.91	11.34	31.53	81.90	278.10	
PERCENT HL	35.96	.74	3.19	9.17	6.08	4.08	11.34	29.45	100.00	

TABLE B-III

BLOCK 2 : TBHP ALKYLATION TO DTBP

BLOCK STREAM 1 : TBHP/TBA FROM PEROXIDATION
-- FEED STREAM FROM BLOCK 1 --

*** S- 5 ***

METHANE =	0.000000	METHANOL=	8.540131	METHYLAL=	0.000000
CRB DIOX=	0.000000	TBUTANOL=	137.897213	GLYCOALD=	0.000000
HYDROGN =	0.000000	ETH GLY =	0.000000	ETHANOL =	0.000000
OXYGEN =	0.000000	GLYCERIN=	0.000000	CRB MN0X=	0.000000
I-BUTANE=	0.248960	TBHP =	280.159745	12PRDIOL=	0.000000
N-BUTANE=	0.414374	DTBP =	0.000000	13PRDIOL=	0.000000
I-BUTENE=	0.000000	TETRAOL =	0.000000	ME ETHER=	0.000000
MEFORMAT=	0.000000	WATER =	21.550750	CYHEXANE=	0.000000
ACETONE =	8.550475	FORMALD =	0.000000	NA HCO3 =	0.000000

TOTAL MOL = 457.361648

TOTAL WGT = 36665.9863

AVERG MWT = 80.1684760

BLOCK STREAM 2 : ISOBUTYLENE FEED
-- RECYCLE STREAM FROM BLOCK 15 --

*** S- 9 ***

METHANE =	1.407838	METHANOL=	0.000000	METHYLAL=	0.000000
CRB DIOX=	0.000000	TBUTANOL=	0.042024	GLYCOALD=	0.000000
HYDROGN =	0.000000	ETH GLY =	0.000000	ETHANOL =	0.000000
OXYGEN =	0.000000	GLYCERIN=	0.000000	CRB MN0X=	0.000000
I-BUTANE=	0.000000	TBHP =	0.000000	12PRDIOL=	0.000000
N-BUTANE=	0.000000	DTBP =	0.000000	13PRDIOL=	0.000000
I-BUTENE=	280.159745	TETRAOL =	0.000000	ME ETHER=	0.000000
MEFORMAT=	0.000000	WATER =	1.400799	CYHEXANE=	0.000000
ACETONE =	1.407838	FORMALD =	0.000000	NA HCO3 =	0.000000

TOTAL MOL = 284.418244

TOTAL WGT = 15850.7829

AVERG MWT = 55.7305421

BLOCK STREAM 3 : RESIDUAL ISOBUTANE PURGE
-- EXTERNAL FUEL STREAM --

*** S- 10 ***

METHANE =	1.407838	METHANOL=	0.004782	METHYLAL=	0.000000
CRB DIOX=	0.000000	TBUTANOL=	0.004138	GLYCOALD=	0.000000
HYDROGN =	0.000000	ETH GLY =	0.000000	ETHANOL =	0.000000
OXYGEN =	0.000000	GLYCERIN=	0.000000	CRB MN0X=	0.000000
I-BUTANE=	0.208180	TBHP =	0.000000	12PRDIOL=	0.000000
N-BUTANE=	0.222167	DTBP =	0.000000	13PRDIOL=	0.000000
I-BUTENE=	0.000000	TETRAOL =	0.000000	ME ETHER=	0.000000
MEFORMAT=	0.000000	WATER =	0.000000	CYHEXANE=	0.000000
ACETONE =	0.014937	FORMALD =	0.000000	NA HCO3 =	0.000000

TOTAL MOL = 1.86206386

TOTAL WGT = 48.9250136

AVERG MWT = 26.2746165

BLOCK STREAM 4 : DTBP/TBA PRODUCT TO REDOX RX
 -- PRODUCT STREAM TO BLOCK 3 --

*** S- 11 ***

METHANE =	0.000000	METHANOL=	8.535349	METHYLAL=	0.000000
CRB DIOX=	0.000000	TBUTANOL=	137.935098	GLYCOALD=	0.000000
HYDROGN =	0.000000	ETH GLY =	0.000000	ETHANOL =	0.000000
OXYGEN =	0.000000	GLYCERIN=	0.000000	CRB MNOX=	0.000000
I-BUTANE=	0.040760	TBHP =	0.000000	12PRDIOL=	0.000000
N-BUTANE=	0.192187	DTBP =	280.159745	13PRDIOL=	0.000000
I-BUTENE=	0.000000	TETRAOL =	0.000000	ME ETHER=	0.000000
MEFORMAT=	0.000000	WATER =	22.951548	CYHEXANE=	0.000000
ACETONE =	9.943376	FORMALD =	0.000000	NA HCO3 =	0.000000

TOTAL MOL = 459.758083

TOTAL WGT = 52467.8442

AVERG MWT = 114.120548

BLOCK STREAM 5 : RX STOICHIOMETRY
 -- INTERNAL REFERENCE STREAM --

*** S- 12 ***

METHANE =	0.000000	METHANOL=	0.000000	METHYLAL=	0.000000
CRB DIOX=	0.000000	TBUTANOL=	0.000000	GLYCOALD=	0.000000
HYDROGN =	0.000000	ETH GLY =	0.000000	ETHANOL =	0.000000
OXYGEN =	0.000000	GLYCERIN=	0.000000	CRB MNOX=	0.000000
I-BUTANE=	0.000000	TBHP =	-1.000000	12PRDIOL=	0.000000
N-BUTANE=	0.000000	DTBP =	1.000000	13PRDIOL=	0.000000
I-BUTENE=	-1.000000	TETRAOL =	0.000000	ME ETHER=	0.000000
MEFORMAT=	0.000000	WATER =	0.000000	CYHEXANE=	0.000000
ACETONE =	0.000000	FORMALD =	0.000000	NA HCO3 =	0.000000

TOTAL MOL = -1.00000000

TOTAL WGT = 0.00000000E+00

AVERG MWT = 0.00000000E+00

BLOCK STREAM 6 : RX FEED
 -- INTERNAL REFERENCE STREAM --

*** S- 13 ***

METHANE =	1.407638	METHANOL=	8.540131	METHYLAL=	0.000000
CRB DIOX=	0.000000	TBUTANOL=	137.939237	GLYCOALD=	0.000000
HYDROGN =	0.000000	ETH GLY =	0.000000	ETHANOL =	0.000000
OXYGEN =	0.000000	GLYCERIN=	0.000000	CRB MNOX=	0.000000
I-BUTANE=	0.248960	TBHP =	280.159745	12PRDIOL=	0.000000
N-BUTANE=	0.414374	DTBP =	0.000000	13PRDIOL=	0.000000
I-BUTENE=	280.159745	TETRAOL =	0.000000	ME ETHER=	0.000000
MEFORMAT=	0.000000	WATER =	22.951548	CYHEXANE=	0.000000
ACETONE =	9.958313	FORMALD =	0.000000	NA HCO3 =	0.000000

TOTAL MOL = 741.779891

TOTAL WGT = 52516.7692

AVERG MWT = 70.7963187

BLOCK 2 MASS BAL, PROD-FEED WGT : 0.0000000000E+00